Outline

• An Introduction to Asian Nano Forum (ANF)
• Some Singapore activities

- Education
- Standards
- EHS
First Meeting in May 2004

Participants from 13 economies in the Asia Pacific Region consisting of:

- Australia, China, Hong Kong, India, Indonesia, Korea, Japan, Malaysia, New Zealand, Singapore, Taiwan, Thailand, and Vietnam

Goal: To promote excellence in research, development and the economic uptake of nanotechnology within the Asia-Pacific region
**Objectives of the ANF**

6 startup objectives

1. **Foster** nanotech in the region by creating mechanisms to share information, resources and expertise.

2. **Coordinate** joint investment in major infrastructure by member economies.

3. **Initiate, promote and manage** co-operative scientific and technology research projects.

4. **Support** regional economic and environmental development through joint projects.

5. **Enhance** public awareness and education of nanotechnology and associated social, environmental, health and economic issues.

6. **Act** as an advocacy group for nanotechnology in the region.
Initial Activities

- Workshops
- Steering Committee Meetings
- A Summit Meeting in Geelong, Australia in December 2005
  - To establish a HQ in Bangkok
  - Working groups in Education, Research & Infrastructure, Business & Commercialisation, Standardisation, Risk Assessment & Safety
• All participants shared information on activities
• Working groups up and running
• HQ registered
• Executive Committee formed to run operational affairs of ANF, chaired by Prof MK Wu/Taiwan
• Next summit in 2007 to be hosted by Malaysia
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An Example: Standardisation

1) Participants voted for ANF to be a Liaison Member of ISO/TC 229
   – International body in liaison with ISO technical committee
   – Enable ANF member economies (broader than usual ISO membership) to participate in the development of standards for nanotechnology
TC Liaison Representation

• Liaison membership provides a way for international organizations to participate in (category A liaison), or to be informed about (category B liaison), the development of standards, and thus to ensure wider acceptance of the final result and to ensure coordination of parallel standardization activities in different bodies.

• To be effective, it is normal to establish reciprocal arrangements, which will usually involve the exchange of basic documents, including new work item proposals and working drafts.
**Good progress to some startup objectives**

*Foster* nanotech in the region by creating mechanisms to share information, resources and expertise

*Excellent Start in sharing information;*

*Slower in sharing resources and expertise*

*Enhance* public awareness and education of nanotechnology and associated social, environmental, health and economic issues

*Sharing already started including conference in Taiwan this year*

*Coordinate* joint investment in major infrastructure by member economies

*Working group reported preliminary steps in HK.*

*Act* as an advocacy group for nanotechnology in the region

*One good example vis a vis Malaysian Government*
Challenges Ahead

1. Moving to an organisational model
2. Establishing a role for a regional forum
3. A sustainable business plan
4. .......
Singapore Overview

- **Physical:**
  - Land area: 699 sq km
  - Limited natural resources
  - Geographical position
  - Natural harbour

- **Population:**
  - 1960: 1.60 million
  - 2005: 4.35 million
  (including 798K expatriates and migrant workers)

- **Economy (GDP):**
  - 1960: S$2.1 billion
  - 2005: S$193 billion

- **Foreign reserves:**
  - 1963: S$1.2 billion
  - 2005: S$193.6 billion

- **Political landmarks:**
  - 1959: Self-government
  - 1963: Merger in Federation of Malaysia
  - 1965: Independence (separation from Malaysia)
High Level of R&D Activity

GERD as % of GDP

Sweden 4.0%
Finland 3.5%
Japan 3.2%
Korea 2.6%
USA 2.6%
Switzerland 2.55%
Denmark 2.5%
Taiwan 2.45%
Singapore 2.25%
Netherlands 1.8%

Source: OECD Main Science & Technology Indicators (MSTI) database, May 2005

Aim to grow to 3% of GDP
~ ⅔ Private Sector
~ ⅓ Public Sector Agencies
Fusionopolis: Where Science meets Business & the Arts
Singapore's most powerful Computers - driving innovations

S'pore's largest R&D cleanroom at your service
State-of-the-art cleanroom

A Magnet for the Best and Brightest
Outstanding researchers with diverse cultures to create highly inventive environment

Science meets business
Partnering industry in joint development of next generation technologies

Small Matters!
produce high-resolution, 3D images down to an atomic level

Bringing Technology From the labs to Your Daily Experience
experimental place to innovate and create ideas for R&D and new applications

Fusionopolis – Where Science meets business and the Arts

Area of Phase 1 : 120,000m²
Area of Phase 2 : 65,000 m²
No. of Researchers : > 1600
New Activities
School Outreach & Public Education
Upcoming Initiative

An entire exhibition hall on Nanotechnology targeting students and the general public
### Display Themes for Nanotechnology Exhibition

<table>
<thead>
<tr>
<th>2 Sides of the Coin</th>
<th>Art of Covering more with less - How is it like in the Nano World?</th>
<th>Asbestos – Magic mineral or Deadly Dust</th>
<th>Atomic Force Microscopy - Visualising in the Nano world</th>
<th>Brownian Motion</th>
<th>Camera Swarm</th>
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<tbody>
<tr>
<td>Carbon Nano-Tube</td>
<td>DDT – Blessing or Bane</td>
<td>DuckyBoy in Nanoland - How is it like in the Nano World?</td>
<td>Fluid Bodies</td>
<td>Kaleidoscope</td>
<td>Massive Parallelism - Bottom-up fabrication</td>
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<tr>
<td>Mighty Inter-Atomic Forces</td>
<td>Nano Art Gallery</td>
<td>Nano-Duck Cloth</td>
<td>Nano History - How Did Nanotechnology Evolve?</td>
<td>NANOMANDALA - The beautiful invisible world</td>
<td>Nano-Silver</td>
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<td>Nano-Somes</td>
<td>nCode</td>
<td>Powers of Ten</td>
<td>Precautionary Principle</td>
<td>Printing Small - Top-Down Fabrication</td>
<td>QuANUMTUNNEL - How is it like in a Nano world</td>
</tr>
<tr>
<td>Scanning Probe Microscopy - Visualising in the Nano World</td>
<td>Self-Assembly Boxes - Bottom-up fabrication</td>
<td>What is Nanotechnology?</td>
<td>ZEROWAVE (Buckyball projection)</td>
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An Example: Atomic Force Microscopy - Visualising in the Nano world

A roller follower (representing the tip of an AFM) is vertically mounted to a horizontal slider (motorised). As the slider is powered, the follower is moved over a surface made with different size spheres arranged one next to the other. An extension to the follower is attached to act as an indicator that will move up and down as it slides over the ‘rough’ surface. The pointer is superimposed over an LCD screen where an animation is created to trace out the path of the pointer as it travels across the screen.
Nanotechnology Labs

Target Group: Primary Schools

Students will appreciate how small a nanometer is and understand some simple concepts behind Nanotechnology. Hands on experiments to illustrate that the smaller an object, the larger its surface to volume ratio. Experiments will be conducted by the students to show that surface area to volume ratio determines the rate of reaction, a clear parallel with nano-sized objects having a massively large area to volume ratio will be drawn.

They will also conduct experiments to understand the difficulty of working with nano-sized objects using macro-sized tools and various ways of manipulating nano-scaled structures.

Target Group: Secondary Schools

Students will have hands on experiments to learn about the dominance of intermolecular forces at nano-scale and the importance of the surface area to volume ratio as things get smaller and smaller.

Students will even get a chance to create actual nano-structures through a series of interesting chemical reactions.
New Activities

Nanometrology
SPRING Singapore

Efforts towards Nanotech Standardization after ANF summit in 2005

SPRING to start off by setting up nanometrology lab to offer measuring and calibration services to companies

Spring spends big bucks to boost ‘tiny’ technology

SPRING Singapore is to spend $10 million on efforts to boost the local nanotechnology industry.

The national standards and productivity agency will spend most of that cash over five years on nanometrology, the science of ensuring measurements are accurate in the “nano-scale”, where things are smaller than one-billionth of a metre.

This is expected to help companies that use nanotechnology to produce precision items like the lenses in digital cameras, biomedical products, and semiconductor chips. Globally, the industry is estimated to be worth more than US$1 trillion (S$1.57 trillion) in a few years.

Spring’s $10 million investment will come from a $50 million fund announced by Trade and Industry Minister Lim Heng Kiang on Tuesday, to make standards here better-recognised, and improve local companies’ access to overseas markets.

Mr Teo Nam Kuan, group director of Spring’s quality and standards group, said: “Singapore’s own nanotechnology research and development sector alone was valued at S$14 billion last year. And this is expected to grow as world demand for nanotechnology-based products increases.”

First up will be a new facility that will be ready by the middle of next year, which will offer services such as measuring and calibration to companies.

It will be housed in Spring’s National Metrology Centre located at the Science Park in Buona Vista.
National Measurement Infrastructure
for Emerging Technologies
National Standards & Conformance Framework

Enhance & Assure Quality of Products and Services
Facilitate Trade

STANDARDS AND CONFORMANCE FRAMEWORK

STANDARDS
• Voluntary Standards
• Regulatory Standards

MEASUREMENT
• Primary Standards
• Calibration
• Legal metrology

CONFORMANCE
• Accreditation
• Quality Assurance
• Certification
• Testing & Inspection

SPRING is the National Standards Body,
National Accreditation Body and National Metrology Authority
5-Year Metrology Roadmap (2004 – 2008)

New measurement capabilities to support:

- Nanotechnology
- Biomedical sciences
- Pharmaceuticals
- Photonics
- IT & Telecoms

- precision length, dimensional, mass, pressure, temperature measurements, micro-forces, optics, low currents

Economic Review Committee (2001/2)  
EDB 2010 Plan  
Science & Technology Plan (2004/5)  
Infocomm Foresight 2015
5-Year Metrology Roadmap

Initiatives

1. Nanotechnology, MEMS & Photonics
2. Biomedical Sciences and Healthcare
3. Infocomm Technology
4. Time Authentication
5. Energy Efficiency
6. CIPM MRA

About $20 million to build new capabilities
5-Year Metrology Roadmap (2004 – 2008)

New measurement capabilities in:

- High precision nanoscale length measurements
- 3-D measurement of form of small objects
- Surface and angle measurements
- Roundness and flatness measurements
- Small current measurements
Corporations and businesses that have nanoscale measuring equipment and need to be sure of the accuracy of their measurement results.

This includes the A*Star research institutes, nanotechnology companies, biotechnology companies, wafer fabs, semiconductor companies, etc.
New Activities
Nanotechnology Standardisation
Singapore’s Involvement in ISO

**ISO President from 1997-1998**
Member of the policy-development committees

**Policy development committees:**
- CASCO
- COPOLCO
- DEVCO

**Council standing committees:**
- Finance (appointed member, 2003-2004)
- Strategies

**Ad hoc advisory groups**


**Appointed member of Commercial Policies Steering Group**

**34 Participating memberships and 85 Observer memberships**

**ISO member since 1966**

**GENERAL ASSEMBLY:**
- Principal officers
  - President
  - Vice-President (policy)
  - Vice-President (technical management)
  - Treasurer
  - Secretary-General
- Delegates of:
  - Member bodies
  - Correspondent members
  - Subscriber members

**COUNCIL**

**CENTRAL SECRETARIAT**

**TECHNICAL MANAGEMENT BOARD**

**REMCO**

Technical advisory groups

Technical committees
Members for the Singapore Work Group for ISO/TC229

Chair: Dr Lim Khiang Wee, A*STAR

**Government Agencies**
- A*STAR
- SPRING Singapore
- Economic Development Board
- National Environment Agency
- Ministry of Manpower
- Public Utilities Board
- National University of Singapore
- Nanyang Technological University
- Singapore General Hospital

**Companies**
- BASF
- Nanomaterials Technology
- Nanoscience Innovation
- Nanofilm Technologies
- Singular ID
- TÜV SÜD PSB Corp
New Activities
Health & Safety
Health Effects of Nanomaterials: A multi-disciplinary study at NUS

Office of Life Science & NUSNNI

Health & Environmental Impacts of Nanomaterials

Chemical & Physical Characterization
- Materials synthesis
- Surface characterization
- Detection development

Physiological Toxicity Studies
- Respiratory system
- Circulatory system
- Nervous system
- Hepatic and renal

Environmental Assessment
- Interaction with environmental pollutants
- Bioaccumulation
Preliminary Results: Inhalation Exposure

*nAu Accumulation in Organs*

**Respiratory system:**
- Lung

**Circulatory system:**
- Aorta

**Hepatic & Renal system:**
- Kidney
- Adrenal gland

**Nervous system:**
- Thalamus/hypothalamus
- Hippocampus
- Olfactory bulb
- Striatum

1. Need to evaluate the potential impacts of engineered nanomaterials prior to mass production or release into the environment. This should include:
   a. Need to support R&D of nanotechnology applications and
   b. Need to standardize nomenclature and test protocols for maximum comparability of test results and for ready generalization

2. Need to raise public awareness of risks (based on sound evaluation).
1st Rule of Lab Safety:

Managing A Nano World

Workplace Safety and Health Issues

Never use a live chicken.
The Workplace Safety and Health Act

- Gazetted in March 2006, effect from Sep 2006
- Higher penalties for poor safety management
- Emphasise importance of good OSH management systems
- Risk assessment/management
  - Onus on employer, “principal”
  - Must take “reasonable practicable measures” to eliminate/ minimise any foreseeable risk
- Maintenance of risk assessment records
- Specification of roles and responsibilities of persons involved
- Communication of risks to workers
- Incident reporting
Implications of WSHA to Nanotechnology

• Nanotech is not specifically mentioned in the Work Safety & Health Act, but is covered by default
  – factories, laboratories as “workplaces” (1st schedule)

• Risks are implied, but not attributed directly to nanotech
  – Explosion due to ignition of dust under “dangerous occurrences” (2nd schedule)
  – Asbestosis, occupational skin diseases, and liver angiosarcoma under “occupational diseases” (3rd schedule)
  – Explosives, toxic substances, and carcinogens under “hazardous substances” (5th schedule, part II)
Closing Remarks

- Singapore is a small country – therefore must be plugged into the world.
- Education absolutely vital – start young.
- Very large international presence in Singapore industry – learn from everybody; accept best practice from MNCs too.
- Much to gain from participation in international forums such as ISO or ANF – Singapore can be a bridge.
Thank You